

one individual stresses one thing while that of another emphasizes a different element in the same situation.

Matters could not well be otherwise, else we would all be alike as "two peas in a pod"; consequently our character differences rest upon the quantitative differences in the inherited instincts with their accompanying emotions.

With this knowledge before us and with a group classification made between the organic defective with his accompanying psychopathic behavior and the purely functional psychopath where behavior alone is involved, our problem is much simplified and our therapeutic efforts should be more exact. Treatment need not be so empirical as at present where each worker pursues an independent path of his own choosing.

In the true defective only a certain degree of progress is possible. If the upper limit of such progress lands him well within the public "safety zone," well and good. If such goal is not possible, segregation is all that can be done, and under such grouping he must be handled.

In the case of the functional psychopath, treatment becomes a matter of reëducation, but not in a situation where he is confined only a few hours a day. The individual should be kept in the new surroundings, to which he has been sent, and where a real effort is made to understand him and his difficulties, and solutions of his personal problems are worked out with him.

We should bear in mind that in our efforts to re-educate the individual we have not only to change his whole attitude toward life, but we also have to overcome stereotyped, habitual and automatic behavioristic activities which have become "fixed" from long usage.

THE RADIO KNIFE IN DERMATOLOGIC SURGERY*

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DISCUSSION by Harry E. Alderson, M.D., San Francisco; Sumner Everingham, M.D., Oakland; Suttan H. Groff, M.D., Long Beach; William L. Clarke, M.D., Philadelphia, Pa.; George Austin Wyeth, M.D., New York, N. Y.

THE radio[†] knife is an instrument which divides tissue by means of an electric arc which is formed at the point of contact between knife and tissue. It has been used mostly in the surgery of the malignancies, especially by Doctor Clarke of Philadelphia and Doctor Wyeth of New York. Very little has appeared in the literature in regard to this modality. Mention has been made of it by Wyeth, Clarke, and Ward in articles dealing with electrothermic therapy in general. Ward¹ has given an excellent description of the physics of the modality, and has shown microphotographs of tissues cut by it. Hollander² has recently written an article concerning its use in dermatology. I have been using this knife for about two years in my private practice and on my service at the Alameda County Hospital, where considerable cutaneous surgery is done. It has worked so satis-

factorily that I have come to look upon it as almost indispensable.

PHYSICS OF THE CURRENT

The current employed is a bipolar one with a voltage of about 500 and a milliamperage of about 5. The characteristic feature of the current is that it has a very high frequency, varying from one and a half to six million cycles. The waves are of the undamped type. This type of current can be produced by an instrument employing radio tubes exactly similar to those used for radio telephone transmitters. The original instruments and some of the present ones are of this type. Certain electric difficulties such as burnt-out tubes, failure of the tubes to oscillate, choking of the tubes during operation, have resulted in the development of an apparatus which eliminates the tubes entirely, and depends upon foolproof spark gaps, coils, and condensers to produce the high frequency current. An advantage of this type of construction is that it enables the same outfit to be used for electrocoagulation or electrodesiccation merely by throwing a small switch to the modality desired.

When the knife is brought in contact with tissue an arc is produced which disintegrates the tissue ahead of the knife as it moves along. *The cutting is done by this arc and not by the knife itself.* The arc does this by a process of cell destruction known as molecular disintegration.

METHOD OF USE

An anesthetic is always necessary for operations with this knife. If a local anesthetic is used the area should be blocked rather than infiltrated. Gas-oxygen or chloroform are preferable when a general anesthetic is indicated on account of the danger of the arc igniting ether or ethylene.

One of the wires is attached to a piece of lead foil measuring about six by eight inches. This is fastened to the patient's moistened skin at some site remote from the operative field. The usual plan is to place the lead foil beneath the buttocks and to hold it in place by a towel encircling it and the body. The other wire is attached to the knife. This "knife" is generally a flexible piece of steel about 3 centimeters long, 3 millimeters wide, and 1 millimeter thick. It is held in an insulated handle.

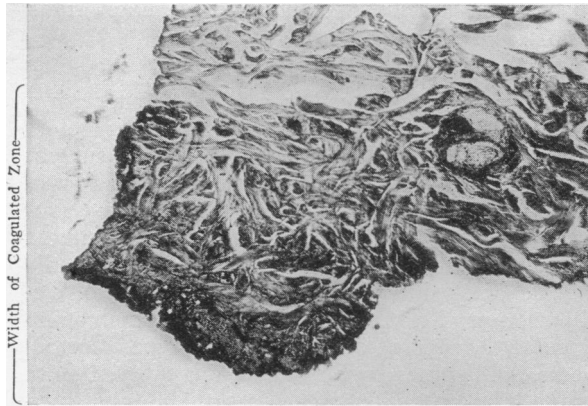
The surgeon should wear rubber gloves to protect himself from shock. I formerly wore two pair of ordinary surgeon's gloves, but now wear only one pair, as I determined by experiment that the voltage used will not penetrate the usual glove. I have never received a shock while operating. A foot switch is of great value in turning the current on and off.

When the knife is brought into contact with the skin an arc is formed which cuts as rapidly or as slowly as the knife is moved. One's first inclination is to attempt to cut with the dull blade just as one would with a scalpel, but this is not desirable. Gentle pressure will carry the knife and arc through the skin with an ease and speed superior to the scalpel. As the arc cuts through the skin the lymphatics and smaller blood vessels are sealed. This lowers the danger of metastasis. More effective blockage of blood and lymph chan-

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* Laboratory work from the laboratories of the Samuel Merritt Hospital, Oakland. Courtesy of Dr. Robert Glenn.

† The terms "radio knife," "endothermy knife," "acusetor," and "high frequency cutting knife" are synonymous.



Showing different depths of coagulation when knife is moved slowly or rapidly
Fig. 1.—Knife moving slowly

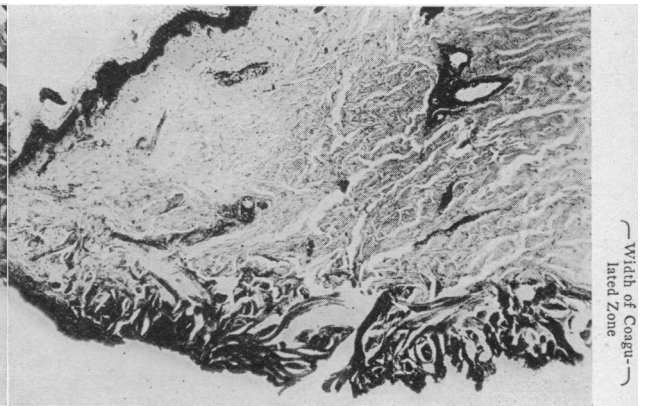


Fig. 2.—Knife moving rapidly

nels is obtained when the knife is moved at a low rate of speed (Fig. 1). I have often removed cutaneous growths without the use of hemostats or ligatures and with practically no loss of blood. This feature is a great convenience in office surgery.

When deeper structures are invaded the larger bleeders are not controlled. Small bleeders can be controlled by turning the switch to coagulation and touching them with the knife for a second or two, thus coagulating them, but vessels of any size should be ligated.

The knife cuts best when the field is kept dry. Also when the area to be cut is kept somewhat taut. After a few minutes' use, the blade becomes coated with a "gummy" layer. This is a nuisance, but is easily scraped off. Some special alloy knife will probably be perfected which will not gum up. When muscles are cut there is an objectionable twitching. It is interesting to note that the knife differs from the actual cautery in remaining cold throughout the operation.

After the operation has been completed the wound can be closed and will heal by first intention, just as if made by a scalpel. However, in closing these incisions I have been playing safe by placing my sutures somewhat close together and leaving them in longer.

A surprisingly gratifying feature of this method is the relative absence of postoperative pain. This is probably due to coagulation of the ends of the severed nerves.

SOME OBJECTIONS TO THE METHOD

Some surgeons have objected to the great speed with which this knife cuts, but this objection can be met by practice and by reducing the amount of current used. It will not cut bone, nor does it cut quite so efficiently in fatty tissue, the fat being a poor conductor of electricity. It cannot be used for "blunt dissection," but a blunt instrument can be kept at hand for this. I know of no way of obviating the annoying twitching produced by this knife when muscles are cut.

EXPERIMENTS

Experiment 1. To demonstrate healing by first intention.—An incision was made through the

skin of a rabbit with the blade of the radio knife moving rapidly. The wound was then sutured. Twelve days later it was seen to have completely healed. The stitches were removed and a portion of the healed incision line was removed for microscopic study. The normal rabbit skin is seen at the right of the photograph in Fig. 3. The healed incision line is seen at the left of the photograph in Fig. 3.

This experiment shows that healing by first intention occurs in rabbit skin within twelve days following experimental incision with the radio knife.

Experiment 2. To demonstrate the width of the zones of coagulation when the knife is moved slowly or rapidly.—A basal cell epithelioma was excised with the radio knife. On one side of the growth the blade was moved rapidly at the rate of approximately three-fourths of an inch per second. The width of the resulting coagulated zone is seen in Fig. 2. On the other side of the growth the knife was moved slowly, at the rate of approximately one inch in five seconds. The width of the resulting coagulated zone is shown in Fig. 1.

This experiment demonstrates that the zone of coagulation laterally from the incision is roughly inversely proportional to the speed at which the knife is moved. The lesson to be learned from this experiment is that one should move the knife

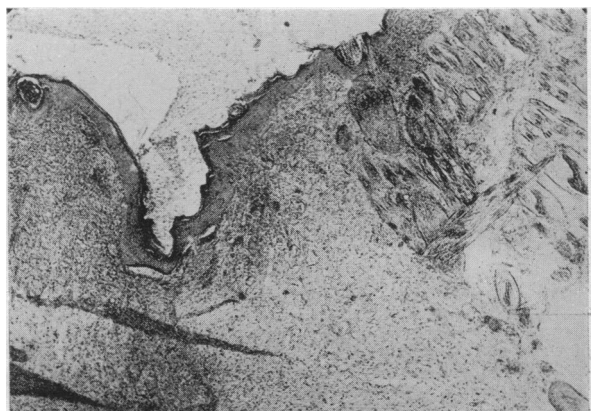


Fig. 3.—Experimental incision of rabbit's skin. Incision healed by first intention in fourteen days

slowly when a malignant tumor is being dealt with. By so doing, a wide zone of blocked lymphatics will be left to guard against metastasis. If cosmetic results are paramount and the lesion benign the knife should be moved rapidly. This will favor healing by first intention.

COMMENTS ON AUTHOR'S CASES

Three enormous carbuncles of the neck were removed in toto. Healing proceeded rapidly and with very little pain.

A tumor of the skin of the chest wall (fibromyxoma) was removed, the wound sutured and perfect healing by first intention followed.

A Pagetoid epithelioma of the buttock measuring about 4 centimeters in diameter was removed, leaving an opening measuring 6 by 8 centimeters. I felt that it would be impossible to close so large a wound, but by undermining the skin and by using many deep tension sutures the edges were approximated. To my surprise the wound healed by first intention.

A number of pigmented moles have been excised. Healing was uneventful except in two cases. In one a stitch infection delayed union. In another a keloid developed in the incision, but the presence of similar keloids in the stitch holes proved that the cutting current was not a causative factor.

I have removed several warts this way, but believe that electrodesiccation is superior.

Several basal cell epitheliomas have been excised with this current, but my impression is that in these cases electrocoagulation, electrodesiccation or radiation are generally preferable. A large basal cell epithelioma was removed from a patient with diabetes. Two days after the stitches were removed the wound opened and later healed by granulation.

Two squamous cell epitheliomas of the dorsum of the hand have been removed and healing followed by first intention (Fig. 4). Four squamous cell epitheliomas of the lip were removed by a combination of electrocoagulation and radio knife. The growths were first completely coagulated and then the coagulated mass was excised with the

radio knife. I believe that this is much safer than radio-knife incision alone.

Working with Doctor Fern a vulvectomy was done for leukoplakia. Doctor Fern commented on the small amount of bleeding and the eliminating of ties. Healing was uneventful.

Dr. Lemuel Adams and I performed a hemiglossectomy for cancer of the base of the tongue. Due to an unavoidable loss of time following the initial operation for ligation of the lingual artery the blood supply had become reestablished and considerable hemorrhage resulted. I believe that it would have been better to have electrocoagulated the whole half of the tongue prior to the radio-knife excision.

Dr. S. Everingham has borrowed my outfit for two radical amputations of the breast. His impression was that this method was superior to the scalpel.

I am routinely removing biopsy sections with this knife, believing that it seals the lymphatics and lowers the danger of metastasis in this procedure.

CONCLUSION

The radio knife has proven a valuable aid to me in dermatologic surgery, especially in the removal of cutaneous malignancies. It does not supplant, but rather supplements, other established procedures.

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REFERENCES

1. Ward: J. A. M. A., Vol. 84, February 28, 1925.
2. Hollander: M. Rev. of Rev., April, 1928.

DISCUSSION

HARRY E. ALDERSON, M. D. (490 Post Street, San Francisco).—Doctor Templeton has given us an interesting demonstration of a useful new instrument. One should bear in mind that the action of the radio knife is rapid and, therefore, special care must be exercised in its use. The coagulating action of the current is of great value in preventing small hemorrhages, but one must remember that larger vessels are not closed so easily. Secondary hemorrhages do occur. A local electrical concern (Bush Electric Company) has devised a very useful electrocoagulation handle for Bard-Parker blades, which I am finding to be of value in certain cases. The action is not exactly that of the radio knife, however. With elimination of the radio tubes the knife is more dependable and will be found to be a valuable addition to one's armamentarium.



SUMNER EVERINGHAM, M. D. (1904 Franklin Street, Oakland).—Doctor Templeton in his very able paper has called attention to the so-called "radio knife," or "acusector" (Kelly), in its application to neoplasms of the skin. As used in general dissection of deeper tissues, in my own experience, I have been quite impressed with its value.

We all are on the alert for any agent that will be of aid in combating malignant growth, and it is felt that this knife has a definite field of usefulness.

Several advantages have been claimed for the radio knife among the most notable being the sealing of lymphatics against dissemination of cancer cells during operative manipulation. This very pertinent question is difficult of proof, since we are at a loss to know when or why metastasis to proximal or distal parts takes place. It has been stated that since wounds heal per primum after use of this electrothermic agent, there can be little actual tissue destruction or closing



Fig. 4.—Illustrating healing by first intention. Photo taken twenty-one days after radio-knife excision of epithelioma

of lymphatic channels. However, from inspection of sections illustrated in this article there seems little doubt that the lymphatics would be more definitely interrupted than after sharp dissection.

It is remarkable how little oozing there is from its use. Large vessels need ligatures and, as stated, should be sectioned between clamps, as the knife does not work well in a moist field. Slightly more distance must be left between hemostats, as the current is dispersed through the clamp if in contact. Smaller vessels can be controlled by touching the bleeding point with the coagulating current or by bringing the electrode in contact with the hemostat.

Primary healing is the rule rather than the exception after such incisions. Another very striking advantage over the sharp dissection is the very definite diminution of postoperative pain. Apparently the nerve filaments when divided are dehydrated much the same as from absolute alcohol to the larger trunks. At any rate the degree of postoperative comfort is quite remarkably greater after use of this method.

There is a relative danger in the possibility of injuring important vessels and nerves when the knife causes contraction of muscle in their proximity. This can be obviated if the muscle is carefully isolated before section or carried well out of the field by retraction. We have had little or no trouble in carrying out our dissection well up in the axilla and about the brachial plexus using this agent after the muscle had been divided.

The radio knife has a definite field of usefulness in general surgery if used with the care and meticulous treatment of tissues needed in any surgical procedure.

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SUTTEN H. GROFF, M. D. (408 Kress Building, Long Beach).—As I am the originator of the diathermy knife referred to by Doctor Alderson, I would like to say a few words in reference to it and to the radio knife. I have been working with the diathermy knife for the past seven years in the treatment of malignancies. Three years ago I operated on two breast cases with the cutting current. I regret its use today. One patient died and the other patient was over eight months healing. I subsequently operated on the other breast in this patient, and the healing process was complete in three weeks. These were bad cases, but I am convinced the results would have been different with diathermy.

For removing biopsy sections in benign tissue I think the radio knife may be ideal. In dealing with malignant tissue I think it should not be considered, for the following reasons: (1) It acts on the same principle as the acetylene torch eating through a steel girder; in severing the tissue the arcing causes a dissemination instead of a sealing of tissues. This is why the technique of coagulation by diathermy and later removal with the radio knife is suggested by the men who use it. (2) In breast amputations or where subcutaneous fatty tissue is encountered the radio knife works poorly, while the diathermy knife will give a clean field with no bleeding and positive sealing of tissues. (3) With the radio knife and diathermy coagulation combined, it is always necessary to keep in mind while operating which current is in use. Coagulation with the radio knife gives a severe reaction, which cannot be estimated at the time of operation. Near important structures this might cause untoward complications. (4) The mass can be dissected out with the diathermy knife with our technique and with sufficient coagulation and sealing of the tissues, and with a saving of time. (5) The principle of the diathermy knife, "The current density varies as to the square of the surface applied," gives a technique with a light current or low milliamperage, which is more readily controlled and safer to work with than forcing a heavy current and heavy arcing through the tissues, especially near important structures. (6) With the diathermy knife I can easily do a radical breast amputation complete with no sutures except skin-tension sutures. (7) With the light current required there is no shock or per-

ceptible shorting from the patient to the bare or to the gloved hand of the operator.

A word as to the healing. No more scarring follows the diathermy than the radio knife. In making biopsy sections healing by first intention will be found about the same, with proper technique. In work near malignant tissue we should require a little coagulation and the skin flaps will heal a little slower, but if in apposition they will heal by absorption of the slough and a substitution of scar tissue.

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WILLIAM L. CLARKE, M. D. (2215 Walnut Street, Philadelphia, Pennsylvania).—No two men employing high frequency currents in various ways will ever agree upon details of application, though all may be doing excellent work because of their familiarity and expert employment of their own technique. My experience with the radio knife indicates that its field of application is but limited, there being other applications of high frequency currents that can be used to greater advantage. I do not think it will replace the scalpel in such operations as amputation of the breast and resection of axillary glands. While it is quite true that a very clean operation may be performed by one expert in the use of this knife, there is danger of sustaining the applicator too long at certain points. Then the wound will not heal by first intention, but a gaping wound will result, to the embarrassment of the operator and to the disappointment of the patient. The radio knife does not seal the lymphatics sufficiently to obviate the possibility of metastasis, for the reason that it is very superficial in action; circulation is only slightly impaired, as evidenced by the healing by first intention in a majority of the cases. It certainly cannot influence any metastasis that has already taken place. While there is less capillary oozing, it does not in any way relieve us of the necessity of ligating the larger vessels. I have had gaping wounds following the use of the radio knife, and I know gaping wounds have occurred many times in the experience of others. Of course I realize that, in a measure, this result is a matter of technique, but personally I have discontinued using the radio knife in breast amputations and in resections generally.

It may be desirable to employ it in making biopsies, but in my own practice I have taken a section only when prepared to make a frozen section study at once. Then I see no advantage of the radio knife over the scissors or the scalpel, providing the base is immediately desiccated to stop hemorrhage and, in a more efficient way, seal lymphatics, although there is very little danger of stimulating metastasis in the short period of time elapsing between the taking of the section and the operation whatever it may be.

I disapprove of the radio knife in cutting out malignant lesions that have been desiccated or coagulated. I prefer the scissors, curette, or scalpel for this purpose, as it gives a better idea of the character of the base, which is important in determining whether malignant tissue remains or not. In case of incomplete work the first time, electrocoagulation or desiccation may be employed with a greater degree of intelligence and accuracy than if the radio knife were employed to cut out the coagulated area. One can detect the resistance of the tissues and make a more intelligent determination whether the disease exists or not with the instruments mentioned than with the radio knife, which will cut through cartilage and fibrous tissue. Therefore mistakes are more likely to occur in the recognition of the tissues characteristic of malignant disease.

I do not approve of the radio knife in the treatment of cancer of the lip, for here it is necessary to suture the same as though a classical scalpel operation were performed. I prefer to desiccate or coagulate, permitting the wound to heal by third intention. There is less deformity and, in my experience, less danger of recurrence.

I believe that no one should treat malignant disease in any form without having at his command radium, x-ray, operative surgery, and electrothermic

methods, for all have their uses and should be used alone or in combination, to suit the requirements of the individual case. There are exceptions, however, in which the radio knife can be used for resection to advantage. In cases where there is a very hemorrhagic area the mass may be quickly removed by this method, but it should be followed, in most cases, by electrocoagulation, since the action of the radio knife current is quite superficial. Indeed, if it were not it would defeat the purpose of the knife.

I think, generally, the desiccation method is better in dermatologic practice than the radio knife. Desiccation is subject to perhaps greater control. The amperage is low and the voltage high. Therefore there is less secondary inflammation. Keloids are certainly more likely to occur with a high amperage current than with a low one, and generally the cosmetic effect is superior from desiccation.

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GEORGE AUSTIN WYETH, M. D. (667 Madison Avenue, New York).—Nothing is more immediately important than the spread of definite knowledge concerning recent advances in the application of electrothermic methods to the eradication of malignant conditions.

Since high frequency currents are a highly destructive force, no one should undertake to use them in surgery or in the treatment of skin conditions who has not been properly trained in that use. This training is not difficult to secure, and the skill it gives to the surgeon is well worth the effort needed to acquire it.

The best machine for cutting is one based on radio frequency. The old spark-gap machine was experimented with by DeForest more than twenty years ago and failed to stand up. Not until the perfected radio-tubes instrument was offered did the profession have an adequate machine. I am still using my original endotherm, which is now over four years old.

Rubber gloves for the operator are not needed. There is no shock to the user of a well-made machine. Such an instrument will provide three distinct currents which are interchangeable at will: the monopolar which desiccates or dehydrates the tissues (the current which Doctor Clarke has so ably developed); the bipolar, or coagulating, which is valuable as causing a more widespread destruction than does the monopolar current; and, finally, the cutting current or endotherm knife.

Dr. Howard A. Kelly of Baltimore was one of the first to welcome the advance offered by this cutting current. Many papers read before various medical and surgical gatherings and published in our professional journals attest his praise of the new method and his success in its use. He has said: "I give this (the endotherm knife) the leading place and decided preference in my daily work, relegating the scalpel to a subordinate position."

Word also comes from London that the great surgeon, Handley, is now using the cutting current in his breast work. It is recommended on the ground of time saved during the operation; decreased danger of mechanical implantation because lymphatics are sealed off as it cuts; decreased danger from hemorrhage; soft, pliable scar following healing by first intention.

The endotherm knife properly controlled and properly used cuts fatty tissue, and the axilla can be cleaned out with it as well or better than with the scalpel. Primary healing is in direct relation to the skill used in making the incision. If the operator stops and allows the current to arc between the cut surfaces he will carbonize the tissue and prevent proper healing, for carbonized surfaces will not unite. But that is not the fault of the method; it comes from faulty technique.

The best technique in performing hemiglossectomy calls for a preliminary ligation of the vessels of the neck at time of operation and a line of coagulating necrosis drawn in healthy tissue around the malig-

nant area. The cutting current is then switched on and the incision made through the coagulated path, obviating hemorrhage and shock.

Of the extension of electrosurgery's usefulness in removing brain tumors we have ample testimony in an article by Dr. Harvey Cushing of Boston, written for the December, 1928, number of *Surgery, Gynecology, and Obstetrics*. The new method is so rich in benefits to patient and operator it needs only to be sincerely studied and carefully employed in order to be adopted permanently.

PROTOZOAL INFESTATIONS*

A GROUP STUDY—SOME NOTES ON STOVARSOL TREATMENT

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DISCUSSION by L. M. Boyers, M.D., Berkeley; R. J. Pickard, M.D., San Diego.

DURING recent years numerous authors have given us a wealth of material and statistics endeavoring to prove or disprove the pathogenic rôle of the intestinal protozoa. The controversy has become quite acute.

VIEWPOINTS OF DIFFERENT OBSERVERS

On the one hand we find an author who states that "in California, at any rate, the harmless, possibly beneficial fecal scavenger is sometimes not only reviled but made a source of profit to its detractors."¹

On the other hand many authors, including Reed, Kofoid, Kessel, Kirenén, Pickard, and Boyers are firmly convinced that most of the protozoal parasites infesting the human bowel are at times pathogenic. Quoting from these authors we find that Kirenén² is convinced that "experience shows that in the great majority of cases the carrier remains quite healthy and we must come to the conclusion that it is the normal function of the normal epithelium that holds the amebae in check. If, however, the normal resistance lessens (for instance, by an indigestion or by other illnesses which interfere with the function of the intestines) the amebae grow out into bigger forms, and irritation results giving the symptoms of simple colitis and dyspepsia." Reed³ states that "it is hard to believe that any of these organisms (ciliates, flagellates, and amebae) can live and multiply in the human host without the possibility of their parasite host's balance being at times disturbed and symptoms resulting." Experience "makes me doubt if they ever infest man without increasing the health hazard of the host." Even some of the flagellates are accused of producing symptoms and Kessel⁴ states that "*Pentatrichomonas* have been found repeatedly in patients suffering from a diarrhea usually of a chronic type." From Thomas and Baumgartner⁵ we quote: "While some men believe that *Giardia* is nonpathogenic, still of some of the worst cases of parasites (in our series), three at least, have been caused by *Giardia*." Pickard⁶ believes that

* Read before the Pathology and Bacteriology Section of the California Medical Association at its Fifty-Seventh Annual Session, April 30 to May 3, 1928.